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Compact spectral characterization of 10-500 MeV γ-rays from the Texas Petawatt Laser-Driven Plasma Accelerator

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GeV (γ_e > 2000) electron bunches from petawatt-laser-driven plasma accelerators can be converted to tunable, narrowband or to broadband continuum γ-ray ($h\nu$ > 10 MeV) pulses by Thomson backscattering (TBS) or bremsstrahlung, respectively. Inserting a plasma mirror (PM) near the accelerator exit converts electrons to γ-rays compactly and inexpensively [1], in a TBS/bremsstrahlung mixture determined by PM thickness, material and location. Characterizing the γ-ray spectra accurately is a challenge, usually addressed with bulky pair production/Compton spectrometers. Here, we spectrally characterize PM-generated TBS/bremsstrahlung γ-rays from 1-2 GeV Texas-Petawatt-Laser-accelerated electron bunches using a compact stack calorimeter, consisting of alternating absorbers and imaging plates, to record energy-dependent particle showers generated by incoming γ-rays. An iterative Bayesian algorithm, based on a calorimeter response matrix built from GEANT4 simulations, reconstructs TBS and bremsstrahlung contributions for each shot, as PM and electron parameters vary. The method should be widely applicable to plasma-accelerator-based radiation with MeV photon energies.

[1] H.E. Tsai et al., Phys. Plasmas 22, 023106 (2015); T. Phuoc et al., Nat. Phot. 6, 308–311 (2012); A. Döpp et al., Plasma Phys. Control. Fusion 58, 034005 (2016); C. Yu et al., Sci. Rpts. 6, 29518 (2016)

Primary authors: HANNASCH, Andrea (University of Texas at Austin); LASO GARCIA, Alejandro (Helmholtz Zentrum Dresden Rossendorf); DOWNER, Michael (The University of Texas at Austin)

Co-authors: Mr LABERGE, Maxwell (University of Texas - Austin); LISI, Luc (The University of Texas at Austin); CHENG, Xiantao (The University of Texas at Austin); BROOKS, Jason (The University of Texas at Austin); BOWERS, Brant (The University of Texas at Austin); PAGANO, Isabella (The University of Texas at Austin); SPINKS, Michael (The University of Texas at Austin, Center for High Energy Density Science); QUEVEDO, Hernan (The University of Texas at Austin, Center for High Energy Density Science); DONOVAN, Mike (The University of Texas at Austin, Center for High Energy Density Science); ZGADZAJ, Rafal (The University of Texas at Austin); BERNSTEIN, Aaron (The University of Texas at Austin); DITMIRE, Todd (The University of Texas at Austin, Center for High Energy Density Science)

Presenter: HANNASCH, Andrea (University of Texas at Austin)

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